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## FAMILIES OF AMERICAN MEN OF SCIENCE

BY J. McKEEN CATTELL

## II. MARRIAGES AND NUMBER OF CHILDREN

THERE are thousands of volumes containing vital statistics, but exact studies of definite groups of individuals have scarcely been made. It is often assumed that we must have vast numbers of cases, such as are obtained by a national census, in order to secure valid statistics, but in some directions better scientific results can be obtained by applying more careful methods to a limited number of cases. The difficulty in obtaining correct statistics is not the variable error, which decreases with the number of cases, but the constant errors, which can only be eliminated by proper methods. Thus, for example, I find that the parents of 871 scientific men had families of the average size of 4.65 children, with a probable error of 0.05. The chances are even that increasing indefinitely the number of cases would give a figure varying only between 4.6 and 4.7, and this is as close a determination as is needed. But a serious mistake would be made if it were assumed that the average family of the class from which the scientific men come were as large as 4.65. The fathers of 865 scientific men died at the average age of 70.6 years and their mothers at the average age of 70.2 years. The chances are even that this figure is correct within one third of a year, and this is all we need to know. It would, however, be incorrect to use these figures to prove that people of that class and generation lived to the age of seventy years or that the men lived longer than the women. In the census of 1880 there were found to be in the United States 170,000 more children in their second than in their first year. As over one tenth of all the children died in their first year, this result is incredible, and the large number of cases only makes the absurdity more obvious.

The table shows that of just one thousand leading scientific men for whom the information is at hand 105 are unmarried. 18 per cent.

TABLE IV. NUMBERS AND PERCENTAGES OF SCIENTIFIC MEN WHO ARE UNMARRIED IN ACCORDANCE WITH THEIR AGES

|               | Ages of Scientific Men |       |       |       |      | Total |
|---------------|------------------------|-------|-------|-------|------|-------|
|               | -39                    | 40-49 | 50-59 | 60-69 | -70  |       |
| Number.....   | 150                    | 402   | 269   | 131   | 48   | 1,000 |
| Unmarried..   | 27                     | 42    | 19    | 12    | 3    | 105   |
| Per cent..... | 18.00                  | 10.45 | 7.06  | 9.16  | 6.25 | 10.5  |

of those under 40 years of age are single, 10.5 per cent. of those between 40 and 50, and 7.5 per cent. of those over 50. According to the census of 1900, 17.1 per cent. of men 35 to 44 years old are single, 10.4 per cent. of those from 45 to 54, and 7.8 per cent. of those from 55 to 64. There is thus a tolerably close correspondence between the marriages of scientific men and of the general population, but the age groups of the census being five years older, a scientific man is more likely to be married than a man taken at random from the community. This is perhaps contrary to general opinion. A tradition of celibacy for the scholar has been inherited from the Roman Catholic Church, it being only within the time limits of these statistics that fellows of the colleges of the English universities have been permitted to marry. Professor Thorndike<sup>1</sup> found that only 12 per cent. of those in "Who's Who in America" over forty years of age are unmarried. On the other hand, President Eliot<sup>2</sup> found 28 per cent. of Harvard graduates 20 to 25 years out of college to be unmarried. There is a lack of satisfactory statistics of marriage conditions in different classes of the community. For different nations M. Bertillon<sup>3</sup> states the percentage of unmarried men over fifty years of age to vary from 16.3 in Belgium to 3.6 in Hungary, it being 7.5 in Germany and 10.1 in France.

Contrary to a wide-spread opinion, the marriage rate and the age at marriage have not varied considerably in the course of the past thirty years. The number of persons married annually for each thousand of the population in several countries has been as follows:<sup>4</sup>

|                      | 1881-1885 | 1910<br>(or 1909) |
|----------------------|-----------|-------------------|
| France.....          | 15        | 15.8              |
| German Empire.....   | 15.4      | 15.5              |
| Italy.....           | 16.1      | 15.5              |
| England and Wales... | 15.2      | 15                |
| Sweden.....          | 12.8      | 12                |

In England and Germany the rate was highest in the quinquennial period 1896-1900, reaching 16.1 and 18.8, respectively. The percentage of women between 15 and 49 years of age who are married has been:

There has thus been no decrease in marriage corresponding to the decreasing birth rate which has occurred during this period. In France, where the birth rate is the lowest, the marriage rate and the percentage of women married are the highest.

|                      | 1880<br>(or 1881) | 1900<br>(or 1901) |
|----------------------|-------------------|-------------------|
| France.....          | 54.9              | 57.7              |
| Italy.....           | 55.2              | 56.1              |
| German Empire.....   | 51.9              | 52.8              |
| England and Wales... | 51.4              | 49.2              |
| Sweden.....          | 41.4              | 44.2              |

The marriage rate varies from year to year with economic and social conditions, but the percentage of women of child-bearing age

<sup>1</sup> "Marriage among Eminent Men," *The Popular Science Monthly*, 1902.

<sup>2</sup> Annual Report of the President of Harvard College for 1901-02.

<sup>3</sup> "La Dépopulation de la France," Paris, 1911.

<sup>4</sup> Report of the Registrar-General (England and Wales) for 1910.

who are married proves that marriage is as usual now as it was a generation ago. The conditions, however, are extremely complicated, being influenced by birth rates, death rates, the age constitution of the people and immigration. The European nations with the exception of France have supplied great numbers of immigrants during the past thirty years; these are largely people of marriageable age with an excess of unmarried men. This circumstance makes it more significant that there has been no decrease in marriage in these nations. It explains in large measure the relations in France and England, the latter country having been left with an excess in its population of over a million women above fifteen years of age. The comparatively high birth rates and death rates of a generation ago, followed by the decreasing birth rates and death rates which have obtained in nearly all nations for the past forty years, give a large percentage of the population between twenty and forty years of age, and are favorable to a high marriage rate and to a large proportion of married people. It is significant of improved conditions regarding the health of married women that among 900 scientific men only 15 are stated to have children by a second wife and the number of children is only 29. The data also show that successive polygamy through divorce is unusual among scientific men.

TABLE V. AGES AT MARRIAGE AND THE SIZES OF FAMILY

| Age.....       | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-  | Av.   | Med.  |
|----------------|-------|-------|-------|-------|-------|------|-------|-------|
| Mother         |       |       |       |       |       |      |       |       |
| Number..       | 85    | 229   | 99    | 21    | 6     |      | 22.88 | 22.29 |
| Size.....      | 5.56  | 4.90  | 4.47  | 2.71  | 2.50  |      | 4.74  |       |
| Father         |       |       |       |       |       |      |       |       |
| Number..       | 5     | 123   | 175   | 88    | 27    | 22   | 27.98 | 26.35 |
| Size.....      | 6.40  | 5.27  | 4.57  | 4.60  | 3.96  | 4.00 | 4.74  |       |
| Wife           |       |       |       |       |       |      |       |       |
| Number..       | 15    | 158   | 165   | 69    | 22    | 11   | 26.63 | 25.65 |
| Size.....      | 2.00  | 2.59  | 2.44  | 1.62  | 0.59  | 0    | 2.23  |       |
| Scientific Man |       |       |       |       |       |      |       |       |
| Number..       | 2     | 67    | 196   | 108   | 39    | 28   | 29.50 | 28.40 |
| Size.....      | 2.00  | 2.27  | 2.56  | 2.14  | 1.62  | 1.18 | 2.23  |       |

In Table V. data are given in regard to the age at marriage and the size of family of our leading scientific men and of their parents.<sup>5</sup> The

<sup>5</sup> The data are for the 440 cases in which the families of the scientific men were "completed" and in which there were no remarriages either of the scientific men or of their fathers. The families were taken as completed when the wife was 45 or older, when there had been ten years of married life without a child or when the period since the birth of the last child added to the mother's age is at least 45. Some of the families are then not absolutely completed, but the births would be very few. None of the 11 women who were more than 39 at marriage had children, although newly married women of this age are more

fathers married at the average age of 28 years and the mothers at the average age of 22.9 years. The median ages are naturally lower than the average ages, as marriage can be postponed beyond the average longer than it can precede this average. The distribution of ages is also shown in the table. Five of the fathers and 85 of the mothers married under the age of twenty, 137 of the fathers and 27 of the mothers beyond the age of twenty-nine, 298 of the fathers and 328 of the mothers between twenty and twenty-nine. The scientific men themselves married at the average age of 29.5 years and their wives were on the average 26.6 years old. The sons married about one and a half years later than their fathers and their wives nearly four years later than the mothers. There is a statistical anomaly in this comparison, especially as regards the mothers, for women who married late would have few children or none, and the average age of the mothers would thus be reduced as compared with the wives. The differences are partly due to the fact that all the scientific men and only part of the fathers belong to the professional classes; and there has probably been an increase in the age of marriage of the professional classes in this country; but the figures show that any such increase must be small.

Bertillon gives the following figures for the average age at marriage in the period 1896-1900:

|              | First Marriages |       | All Marriages |       |
|--------------|-----------------|-------|---------------|-------|
|              | Men             | Women | Men           | Women |
| England..... | 26.6            | 25.1  | 28.4          | 26.2  |
| France.....  | 27.9            | 23.5  | 29.6          | 25.2  |
| Italy.....   | 27.5            | 23.8  | 29.8          | 24.8  |
| Prussia..... | —               | —     | 29.3          | 26.2  |
| Austria..... | —               | —     | 30.9          | 26.8  |
| Sweden.....  | 28.7            | 26.7  | 30.2          | 27.2  |
| Norway.....  | 29.2            | 27.2  | 31.0          | 28.1  |

The age of marriage is highest in the Scandinavian nations; it is lowest in the Slave nations; it is as low in France, with its small birth rate, as elsewhere. In England in the case of first marriages the husband is one and a half years older than the wife, in France, nearly four and a half years older. The age of marriage for first marriages has increased in England by about three fourths of a year since 1896, before which date the registrar-general regards the records as inaccurate. The ages of the consorts at first marriages have increased from 26.59 and 25.08 in 1896 to 27.46 and 25.81 in 1911. The average age at which widowers marry has increased from 44.49 to 46.42; for widows from

likely than others to bear them. A larger error is due to the selection of families, as those having few or no children would be more likely to be completed. The 211 incomplete families have on the average 1.90 children, which is about the same as for the completed families of parents of the same age.

40.58 to 41.74. In the quinquennial period 1876-80, 7.8 per cent. of the husbands and 21.7 per cent. of the wives were under twenty-one, in 1911 these percentages had decreased to 3.9 and 13.3. The professional and well-to-do classes marry later than the average; thus in England, the ages of the men and women are, respectively, about 32 and 27 years, as compared with about 26 and 24.5 years for the artisan and laboring classes. It thus appears that American scientific men marry at a somewhat earlier age than the professional classes in England and their wives are of about the same age.

The table shows that the size of family of the parents of the scientific men—the fraternity of the scientific men—decreases decidedly as the age of the mother at marriage increases. It is about five and a half when the mother is under twenty; it decreases to four and a half when she is between twenty-five and thirty and to scarcely over two and a half when she is between thirty and forty. The decrease would be somewhat greater if barren marriages were included; but it is altered in the opposite direction by the fact that the larger family has the better chance of giving birth to the scientific man. The decrease in the size of family with the advancing age of the father is less, and depends mainly on the fact that older husbands are likely to have older wives. The age of the wife tends to increase about one year as the age of the husband increases by two years. According to the New South Wales statistics, admirably compiled by T. A. Coghlan,<sup>6</sup> the size of the family is five when the mother marries at 21, and as the age of marriage increases to 24, 28 and 32, the size of the family decreases to approximately four, three and two. In the case of the scientific men the family is 2.59 when the mother was 20 to 24 years old at marriage and 2.44 when she was 25 to 29. It is only two in the fifteen cases when she was under twenty. A comparison of these figures with those for the larger families of the preceding generation is significant, as they seem to show the condition when the family is small and limited. Under these circumstances there is but slight difference in the number of children when a woman marries at ages from 15 to 29. After thirty, however, there is a marked decrease, the size of family being 1.6 for women marrying between 30 and 34 and only 0.6 for those marrying between 35 and 39. Less than half of those marrying between 35 and 39 had children and none of those who married at the age of 40 or older had children.

The families from which our scientific men come had on the average 4.7 children, and those scientific men who are married and whose families are complete have on the average 2.3 children, these figures including all the children born. Sir Francis Galton<sup>7</sup> found that a

<sup>6</sup> "The Decline on the Birth Rate of New South Wales," Sydney, 1903.

<sup>7</sup> "English Men of Science," London and New York, 1875.

group of about 100 English scientific men (excluding barren marriages) had, on the average, 4.7 children, and their parents 6.3, and remarks: "This implies a diminution of fertility as compared with that of their parents, and confirms the common belief in the tendency to an extinction of the families of men who work hard with the brain." Mr. Havelock Ellis<sup>s</sup> found that 214 fertile marriages of British men of distinction produced, on the average, 5.45 children, while 276 "genius producing families" consisted, on the average, of 6.96 children, and remarks that "men of genius belong to families in which there is a high birth rate, a flaring up of procreative activity." He says further that this "might, indeed, have been anticipated. The mentally abnormal classes generally belong to families with a high birth rate"; and quotes data in regard to criminals and the insane. Thus two wide generalizations—that intellectual performance conduces to sterility and that genius is allied to insanity—are based on a curious statistical fallacy for which one would suppose Galton the least likely of men to be responsible.

In a population whose families remain of the same average size in successive generations, every one, whether he be a scientific man, a criminal or a tailor, is likely to come from a larger family than he has. If, for example, all families were of one or of seven children equally divided, the average family would be four in each generation, but the children would be seven times as likely to come from the larger family and would belong to a family which, on the average, would be 6.25. With an average family of three, the size of 100 families would be distributed approximately as follows:

|                       |    |    |    |    |    |   |   |   |   |   |    |
|-----------------------|----|----|----|----|----|---|---|---|---|---|----|
| Size of family .....  | 0  | 1  | 2  | 3  | 4  | 5 | 6 | 7 | 8 | 9 | 10 |
| No. of families ..... | 18 | 10 | 20 | 22 | 13 | 6 | 4 | 3 | 2 | 1 | 1  |

When then we count up the average size of the family from which each of the 300 children come, it will be found to be 4.15. As our scientific men come from families of the average size of 4.7, one may conclude that the families of the class to which they belonged were of the average size of about 3.4. In one generation this family has been reduced to 2.3, owing either to a general fall in the birth rate or because scientific men have families which are smaller than those of the classes to which their parents belonged. Both factors are present; there is a general decrease in the birth rate and the educated classes have families smaller than the average.

In Table VI. is given information in regard to the sizes of family of the parents of scientific men in accordance with their nationalities and their occupations. The Germans had families of the average size of 5.7, the British of 4.8 and the native Americans of 4.5. The prob-

<sup>s</sup> "A Study of British Genius," London, 1904.

able errors show that these differences are not due to the limited number of cases. It is known that immigrants from foreign nations have larger families than native Americans, but these figures probably give the only information in regard to the families which produce scientific and other professional men. The disparity is not so great as in the so-called lower classes, but it is sufficient to indicate that in the professional classes descendants of recent immigrants from Germany and Great Britain will in part supplant the descendants of native Americans. It is, however, the case that immigrants are likely to become assimilated to native Americans in size of family as well as in other respects.

The parents of scientific men from the agricultural classes had families of the average size of 5, those engaged in manufactures and trade of 4.6 and those in the professions of 4.5. It was shown in the previous

TABLE VI. THE SIZES OF FAMILY OF THE PARENTS OF SCIENTIFIC MEN IN ACCORDANCE WITH THEIR NATIONALITIES AND THEIR OCCUPATIONS

|                              | No.  | Size |
|------------------------------|------|------|
| American.....                | 625  | 4.45 |
| British.....                 | 131  | 4.83 |
| German.....                  | 67.5 | 5.73 |
| Others.....                  | 47.5 | 5.20 |
| Total.....                   | 871  | 4.65 |
| Professions.....             | 381  | 4.51 |
| Clergymen.....               | 88   | 4.77 |
| Physicians.....              | 65   | 4.22 |
| Lawyers.....                 | 60   | 4.58 |
| Teachers.....                | 75   | 4.39 |
| Others.....                  | 93   | 4.54 |
| Agriculture.....             | 185  | 5.09 |
| Manufacturing and trade..... | 311  | 4.59 |
| Total.....                   | 877  | 4.66 |

article that the agricultural classes contribute in proportion to their numbers only one thirtieth as many scientific men as the professional classes, and this disparity is in-

TABLE VII. THE SIZES OF THE FAMILIES OF THE SCIENTIFIC MEN IN ACCORDANCE WITH THEIR NATIONALITIES

|               | No. | Size |
|---------------|-----|------|
| American..... | 544 | 2.19 |
| British.....  | 49  | 2.43 |
| German.....   | 19  | 3.21 |
| Others.....   | 17  | 1.88 |
| Total.....    | 629 | 2.23 |

creased by their larger families. Among the professions, physicians had the smallest families and clergymen the largest, but the differences are not large, the family of the clergyman being smaller than the family of the farmer. These figures do not, of course, give information in regard to families of the present generation, in which the differences are probably greater.

In Table VII. are given the figures for the children of the scientific men in accordance with their nationalities. The Americans have, on the average, a family of 2.19 children, the British of 2.43 and the Germans of 3.21. The German family is thus nearly 50 per cent. larger than the American. The number of foreign families is, however, too small to give valid averages. It would be very desirable to obtain information in regard to the size of family and other vital statistics for dif-



ferent nationalities and social classes in our population. A single expert in the Bureau of the Census could collect and collate such data in the course of a couple of years at insignificant expense.

Table VIII. gives the sizes of the families from which the scientific men have come and which they have in accordance with the geographical division in which they were born and in accordance with whether they

TABLE VIII. THE SIZES OF THE FAMILIES FROM WHICH THE SCIENTIFIC MEN COME (THEIR FRATERNITIES) AND WHICH THEY HAVE (THEIR CHILDREN), IN ACCORDANCE WITH THE REGION OF THEIR BIRTH AND WHETHER BORN IN THE CITY OR IN THE COUNTRY

| Divisions           | Country Born |      |      | City Born |      |      | Total |      |      |
|---------------------|--------------|------|------|-----------|------|------|-------|------|------|
|                     | No.          | Fr.  | Ch.  | No.       | Fr.  | Ch.  | No.   | Fr.  | Ch.  |
| North Atlantic..... | 206          | 4.40 | 2.34 | 124       | 4.18 | 2.22 | 330   | 4.32 | 2.29 |
| South Atlantic..... | 17           | 4.53 | 2.29 | 17        | 5.12 | 2.18 | 34    | 4.82 | 2.24 |
| South Central.....  | 7            | 5.71 | 2.86 | 5         | 3.80 | 4.40 | 12    | 4.92 | 3.50 |
| North Central.....  | 151          | 4.99 | 2.17 | 44        | 4.75 | 1.77 | 195   | 4.94 | 2.09 |
| Western.....        | 5            | 6.00 | 4.00 | 5         | 6.20 | 1.60 | 10    | 6.10 | 2.80 |
| Total.....          | 386          | 4.68 | 2.31 | 195       | 4.43 | 2.15 | 581   | 4.60 | 2.25 |

were born in the country or in the city. The differences are small. When the parents lived in the country or in small places at the time of birth of the scientific man, they had on the average 4.68 children; and when they lived in towns which in 1900 had a population of 25,000 or over, the size of family was 4.6. The scientific men born in the country had on the average 2.31 children, those born in towns, 2.15. As it will take a long time to correct the common idea that children born in the country are more likely to attain success and distinction than those born in cities, attention may again be called to the fact that 34 per cent. of these leading scientific men were born in cities having in 1860 about 12 per cent. of the population of the country. The greater productivity of cities in men of distinction is doubtless in part due to the fact that the abler and more enterprising people are drawn from the country to the cities, their children inheriting superior ability, and in part to the fact that the city-born children have an environment more favorable to education and to success in scientific work.

The number of families from the southern and western states is too small to give reliable information in regard to the number of children. The fraternities of the scientific men from the North Central States are larger than of those from the North Atlantic States, but their own families are smaller. The differences are small, but apparently significant. The scientific men born in the North Central States came from families of 4.9 and had families of 2.1, those from the North Atlantic States came from families of 4.3 and had families of 2.3. A generation ago the families of the Central States—at least those of this

particular class—were larger than those of the Northeastern States; they are now slightly smaller. The fertile and wealthy state of Iowa had a smaller population in 1910 than in 1900. The increase in the population of the country is maintained by immigrants and the children of immigrants. The 87 scientific men born in Massachusetts had fraternities of 4.1 and families of 2.1 children, the 117 born in New York State had fraternities of 4.5 and families of 2.3 children.

The table shows the great preponderance of the North Atlantic and North Central States in the production of scientific men and the infertility of the south, concerning which statistics have been given by the writer in previous articles. The birth rate of leading scientific men per million of the population has been 107 in Massachusetts, 89 in Connecticut, 47 in New York, 23 in Pennsylvania, 32 in Ohio, 36 in Michigan, 45 in Wisconsin, 24 in Illinois, 12 in Missouri, 9 in Virginia, 5 in North Carolina, 3 in Georgia, 2 in Alabama, 1 in Mississippi and Louisiana. In recent years, however, the North Central States have been gaining and the North Atlantic States have been relatively losing. Thus for younger men the birth rates in figures comparable to those given above have fallen to 85 in Massachusetts, 57 in Connecticut and 36 in New York, whereas they have risen to 35 in Ohio, 74 in Michigan and 54 in Wisconsin. These differences and changes the writer is disposed to attribute in the main to environment rather than to heredity. From the family stocks of Massachusetts, Michigan or Louisiana, we can obtain as many competent scientific men as we care to educate and support.

TABLE IX. THE SIZES OF THE FRATERNITIES AND FAMILIES OF THE SCIENTIFIC MEN IN ACCORDANCE WITH THE INSTITUTION AT WHICH THEY ARE EMPLOYED

|                                   | No. | Fr.  | Ch.  |
|-----------------------------------|-----|------|------|
| Larger universities.....          | 242 | 4.50 | 2.18 |
| Smaller state institutions.....   | 89  | 5.04 | 2.62 |
| Smaller private institutions..... | 122 | 4.69 | 2.29 |
| U. S. government.....             | 73  | 4.64 | 2.00 |
| Commercial and private.....       | 61  | 4.72 | 2.44 |
| Research laboratories, etc.....   | 56  | 4.52 | 2.41 |
| Total.....                        | 643 | 4.65 | 2.28 |

The distribution of the families among different kinds of institutions is given in Table IX. The fraternities of the scientific men are substantially the same in all cases. The only instance in which the departure from the average exceeds the probable error is for the smaller state-supported institutions, and the difference here may not be significant. In the case of the children of the scientific men, the size of family is probably influenced by the environment. The 61 men in the government service, most of whom live in Washington, have the smallest

families, those in the smaller state-supported institutions the largest. The probable errors of the figures are about 0.1, so the differences are not likely to be due to chance. The 61 men in commercial work, or having no institutional affiliations, and the 56 men in research and related institutions have families larger than the average, while those in the larger universities have families smaller than the average. In the larger private universities the situation, for those with 10 or more professors who supplied the information, is: Harvard, 42 families with an average of 2.2 children; Yale, 16 and 2.0; Chicago, 25 and 2.1; Johns Hopkins 12 and 2.1; Cornell, 29 and 2.3; Stanford, 13 and 2.4; Princeton, 10 and 2.5; Pennsylvania, 13 and 2.5; Columbia, 25 and 2.7. The smallest families are at Yale, Johns Hopkins and Chicago, the largest at Princeton, Pennsylvania and Columbia. The larger state universities have professors with the smallest families, the size of family being Michigan, 17 families with an average of 2.1 children; Minnesota, 10 and 1.8; Wisconsin, 15 and 1.7; Illinois, 15 and 1.6.

The figures given are for completed families and for all children born. The death rate for the children of scientific men is unusually small, 75 per thousand to the age of five years and about 120 to the age of marriage. The marriage rate for scientific men is high, 895 among the thousand being married. None the less it is obvious that the families are not self-perpetuating. The scientific men under fifty, of whom there are 261 with completed families, have on the average 1.88 children, about 12 per cent. of whom die before the age of marriage. What proportion will marry we do not know; but only about 75 per cent. of Harvard and Yale graduates marry; only 50 per cent. of the graduates of colleges for women marry. A scientific man has on the average about seven tenths of an adult son. If three fourths of his sons and grandsons marry and their families continue to be of the same size, a thousand scientific men will leave about 350 grandsons who marry to transmit their names and their hereditary traits. The extermination will be still more rapid in female lines.

If the families of the scientific men should increase at the rate of the general population, the thousand leading scientific men would have some 6,000 grandchildren instead of fewer than 2,000. These well-endowed and well-placed people would probably have an average economic worth through their performance of not less than \$100,000, and the money loss due to their non-existence is thus \$400,000,000. The loss to the welfare of the nation and the world from the suppression of the social traditions and the germplasm is incalculable. Until democratic society learns that services for society must be paid for by society, and that the two most important services are scientific research and the bearing and rearing of children, the universities, on which three fourths of our scientific men depend for support, have great responsibilities.

They to a certain extent profess that research is part of the work for which their professors are paid, but they do not acknowledge a similar obligation in regard to the children of professors. Columbia University gives, under certain faculties, scholarships to the sons of professors; Yale University has had a statute by which a married professor received a slightly increased salary; the provisions of the Carnegie Foundation benefit married professors. But these are slight acknowledgments of the obligations of our universities.

President Eliot tells us that "the welfare of the family is the ultimate end of all industry, trade, education and government"; but, in his book on "University Administration," he writes:<sup>9</sup>

The general features of a good scale of salaries are as follows: The salary of an annual appointee at the start should be low, about the amount needed by a young unmarried man for comfortable support in the university's city or village. When, after a few years, this young man receives an appointment without limit of time, a somewhat higher salary should be given him, with a small advance each year for, say, three years. If this instructor so commends himself that the university desires his further service, he should receive, as assistant professor, a salary which will enable him to support a wife and two or three children comfortably, but without luxury or costly pleasures.

The scientific man receives his doctorate at the average age of twenty-seven years and is then eligible for an instructorship with a salary for an "unmarried man"; after "a few years" and then "three years" more he is to receive a salary which will enable him to support "two or three children." President Eliot also says:

The recent tendency of sons of well-to-do, and even rich, families, to go into the ministry, the medical profession, academic life, and the public service, is one in which all patriots may well rejoice. . . . It is a good deal safer to give a life office to a married man on whom marriage has proved to have a good effect, than to a single man who may shortly be married with uncertain results.

There might well be inscribed at Harvard and at other universities the words which President Eliot wrote for the Water-Gate of the Chicago World's Fair, changing one word, so that it would read:

TO THE  
BRAVE WOMEN  
WHO IN  
UNIVERSITIES  
AMID STRANGE  
DANGERS AND  
HEAVY TOIL  
REARED FAMILIES  
AND MADE HOMES

The vital statistics of the United States are entirely inadequate. Where registrations of deaths and births exist, they are imperfect, and the changing population, its age composition and the amount of immigration render them difficult to interpret. The only information concerning birth rates is given by the proportion of children as determined by the census,<sup>10</sup> but even this is unreliable. It might be supposed that it would be possible to determine the number of children by counting them, but this is not the case.

The children reported in the census of 1850 were fewer than the survivors (with the comparatively small excess of immigrants) counted ten years later. There are always more children given as two years old than as one—in 1880 as many as 170,000 more. Nor can we have complete confidence in the compilations of the experts of the census. Thus in the case under consideration they give<sup>11</sup> figures showing that the white population of the United States increased from 1790 to 1800 by 35.7 per cent., adults over 20 by 50.9 per cent., and children under 16 by 38.8 per cent., whence it follows that children from 15 to 19 decreased 22 per cent. This is of course absurd and is due to a gross error of some sort. However, the ratio of white adults twenty years of age and over to

white children under 16, according to the census reports, is shown on the curve. The percentage of children under 16 years of age in the white population increased from 1790 to 1810 and was the same in 1820 as in 1790. In 1810 just half the white population consisted of children under 16; in 1900 the percentage of children had decreased to 35.7.

<sup>10</sup> In January, 1917, was issued the first bulletin from the Bureau of the Census giving birth rates for ten states.

<sup>11</sup> "A Century of Population and Growth," Bureau of the Census, 1909, pp. 80 and 103. An answer to a letter addressed by the writer to the director of the census partly explains the way this error was committed—but the explanation was marked "confidential"! It is, however, no violation of this confidence to state, as the information is available from official reports, that figures were not at hand prior to 1830 and that these were guessed—it appears very awkwardly—so as to give a regular curve.

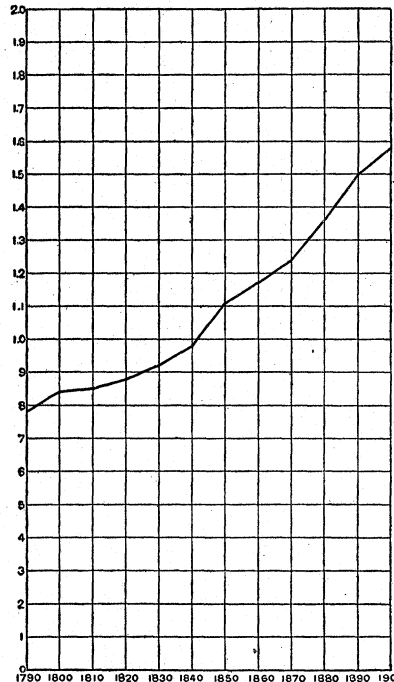


FIG. 1. RATES OF WHITE ADULTS OF SELF-SUPPORTING AGE TO WHITE CHILDREN UNDER SIXTEEN YEARS IN THE UNITED STATES, according to the Bureau of the Census.

From a special study by Mr. Kuczynski,<sup>12</sup> it appears that the birth rate of the native population of Massachusetts has been 63 per thousand women of child-bearing age, as compared with 85 in France, 104 in England and 143 in Russia. Its birth rate per thousand of the population was 17, the size of family 2.61 and of the surviving family 1.92. Special statistics have been gathered for college graduates. President Eliot in his report for 1901-02 stated that 634 married Harvard graduates of the classes from '72 to '77 had an average family of 1.99 sur-

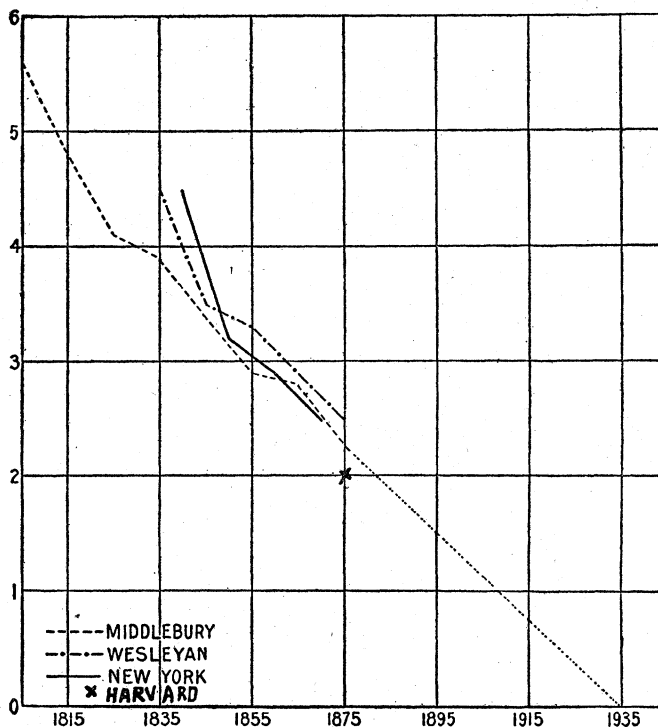


FIG. 2. THE DECREASE IN THE SIZE OF FAMILY OF COLLEGE GRADUATES.

living children. Only 71.9 per cent. of the graduates were married, and the number of children for each member of the class was 1.43. If only 72 per cent. of Harvard graduates are married at the average age of fifty, it is a serious indictment of the kind of men who go to Harvard or of the influences under which they come. We have seen that 91 per cent. of American men of science over 40 are married. Other data concerning the families of college graduates have been published by Professor Thorndike<sup>13</sup> and others.

Curves are here drawn for some of the data, which show that the

<sup>12</sup> *Quarterly Journal of Economics*, November, 1901, and February, 1902.

<sup>13</sup> "The Decrease in the Size of American Families," Edward L. Thorndike, *Popular Science Monthly*, 1903.

gross size of the family of college graduates has decreased from 5.6 at the beginning of the century to 2.5 for classes graduating in 1875, while at that time the size for Harvard was about 2. A projection of these curves—which of course gives no scientific information—shows the curious result that if the decrease should continue at the same rate students graduating in 1835 would have no children. The average college graduate has a family of about the same size as the scientific man of the same age. Data collected for the graduates of Yale,<sup>14</sup> in the classes 1869–86 twenty years after graduation and thus not quite complete, give the following results for different occupations:

Graduates of colleges for women also have had families of about two, but half of them remain unmarried. The Harvard graduate thus has on the average three fourths of a son, the Vassar graduate one half a daughter.

| Occupation         | Marriages | Family |
|--------------------|-----------|--------|
| Clergy.....        | 119       | 2.2    |
| Law.....           | 398       | 2.0    |
| Education.....     | 163       | 2.0    |
| Manufacturing..... | 88        | 2.0    |
| Medicine.....      | 108       | 1.7    |
| Merchant.....      | 82        | 1.7    |
| Miscellaneous..... | 258       | 1.9    |

Since this article was written and published in abstract elsewhere,<sup>15</sup>

there have appeared two excellent articles on the size of family of college graduates. Johnson and Stutzmann<sup>16</sup> find that about half of Wellesley College alumnae graduating from 1879 to 1888 married and had families averaging 1.56 children. John C. Phillips<sup>17</sup> gives data from the class reports of Harvard and Yale students compiled twenty-five years after graduation. Seventy-four per cent. of Harvard graduates and 78 per cent. of Yale graduates had married. The number of children born for each married graduate decreases from about 3 in the fifties to 1.8 in 1890. As Mr. Phillips points out, the decrease becomes slower between 1875 and 1890.

TABLE X. THE SIZES OF THE FAMILIES  
IN ACCORDANCE WITH THE EDUCATION OF THE MOTHER

|           | College | Partial | None | Total |
|-----------|---------|---------|------|-------|
| Under 50  |         |         |      |       |
| No.....   | 109     | 33      | 119  | 261   |
| Size..... | 1.81    | 1.79    | 1.98 | 1.88  |
| 50 to 59  |         |         |      |       |
| No.....   | 58      | 20      | 145  | 223   |
| Size..... | 2.22    | 2.20    | 2.39 | 2.33  |
| Above 59  |         |         |      |       |
| No.....   | 21      | 7       | 117  | 145   |
| Size..... | 2.57    | 3.43    | 2.69 | 2.71  |
| Total     |         |         |      |       |
| No.....   | 188     | 60      | 381  | 629   |
| Size..... | 2.02    | 2.12    | 2.35 | 2.23  |

In Table X. it is shown that the families of scientific men in which the mothers have had a college education are not appreciably smaller than others. If one regards only the total, it appears that when the mother had a college education the aver-

<sup>14</sup> *Yale Alumni Weekly*, 1907.

<sup>15</sup> Proceedings of the First National Conference on Race Betterment, January, 1914; *The Independent*, September 17, 1915.

<sup>16</sup> *Journal of Heredity*, 1915.

<sup>17</sup> *Harvard Graduates Magazine*, September, 1916.

age family is about 2, when she had a partial college education 2.1 and when she had none 2.3, but these differences are chiefly and probably entirely due to the fact that the younger scientific men have the smaller families and at the same time are more likely to marry college graduates. If we divide the scientific men into three age groups, the differences become much less, and if the groups were subdivided still further they would probably disappear. This illustrates the possibility of statistical fallacies when a group is not homogeneous. Of the scientific men under fifty, 109 married college graduates and had families of the average size of 1.81, 33 married women with a normal school or partial college education and the average family was 1.79, 119 married women without a college education and the average family was 1.98. 54 per cent. of scientific men under 50 have married women with a college education; for scientific men from 50 to 59 the percentage falls to 35 and for those 60 or older to 19.

The figures result not only from the increasing numbers of women undergoing higher education, but also from an extension of common scientific interests and pursuits for men and women. A distinguished biologist has observed that "if marriages are made in heaven, Woods Hole may be regarded as a branch office." To the same biologist we owe the remark that "eugenics is an infant industry." There is truth in both epigrams. The percentage of men who have married women with whom they have been thrown into association as teachers or fellow students is large, and we are at present ignorant of the results of such marriages. Small as are the families of scientific men, it is here shown that they are not so because the mother is a college graduate. If both mother and father have common scientific aptitudes and interests, the physical heredity and social traditions should lead the children to follow similar scientific pursuits with an early start and favorable opportunities. I shall be able to give the percentage of fathers and sons, or of two or more brothers, who have engaged in scientific work, and it may be possible to determine the effect when the mother also has scientific interests and ability.

*(To be continued)*